SCIENCE 20/30
BIOLOGY 20/30
CHEMISTRY 20/30
PHYSICS 20/30

DRAFT
PROGRAM OUTLINES

Note:
These draft course outlines reflect the framework and vision for senior high science programs, and include the six major themes that will be part of the final programs. The science, technology and society connections will be included, where appropriate, within the program of studies. We would appreciate your comments on specific content items within each of the units. Your suggestions will help us prepare the draft programs of study that we plan to send out later.

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DRAFT SCIENCE 20-30 PROGRAM OUTLINE

Science 20-30 is an integrated academic program designed to continue development of student understanding of the fundamental science concepts and skills that transcend discipline boundaries. The Science 20-30 program emphasizes six key concepts of science: change, diversity, energy, equilibrium, matter, and systems. These conceptual themes provide a means of showing the connections among the scientific disciplines, and provide a framework for teachers to show how individual sections of the program relate to the big ideas of science.

SCIENCE 20

Unit 1: Changes in Living Systems
(Key Science Concepts: Change, Systems)

- Matter slowly cycles through the biosphere, changing location and chemical combination.
  - biogeochemical cycles: hydrologic, carbon, oxygen, nitrogen, phosphorus, and sulfur
- The biosphere is composed of numerous complex ecosystems through which energy flows steadily.
  - trophic levels, food chains, food webs, ecological pyramids
  - biotic relationships: competition, predation, symbiosis
- Factors such as climate, altitude and latitude determine the specific life forms present in a biome.
  - terrestrial environments: grassland, aspen parkland, boreal forest, alpine
  - aquatic environments: fresh water, salt water, estuaries
  - primary succession, secondary succession
- The theory of evolution explains the diversity of lifeforms and adaptation to habitat.
  - genetic variation, natural selection, Darwin-Wallace theory

Unit 2: The Changing Earth
(Key Science Concepts: Change, Diversity)

- Forces within the Earth cause continual changes on its surface.
  - movement of the Earth's crust driven by nuclear energy in the Earth's core, theory of plate tectonics
- The scientific study of ancient life uses fossils as the primary source of data.
  - paleontology, geologic time scale, fossilization, fossil record, fossil fuels
- The fossil record indicates that climate and life forms on Earth have undergone a sequence of changes over more than a billion years.
  - evolution used to explain the history of life on Earth, relationships among living organisms, and the dependence of life on the environment
- The geologic record indicates that huge glaciers have formed in Arctic regions and flowed south over large areas of Canada several times over the last million years.
  - evidence of ice ages: ice cores, topography, drainage patterns
  - causes of climate change: geometry of Earth's orbit around Sun, composition of atmosphere, volcanic dust

Unit 3: Chemical Changes
(Key Science Concepts: Change, Matter)

- Aqueous solutions provide a convenient medium for chemical reactions.
  - water as a solvent
  - electrolytes and nonelectrolytes, acids and bases,
  - solution concentration (mol/L), dilution
- Balanced reaction equations provide quantitative relationships among the reactants and products involved in chemical reactions.
  - gravimetric and solution stoichiometry, industrial applications (e.g., urea and phosphate fertilizers)
  - reduction and oxidation, metallurgy and corrosion, electrolysis (e.g., chlor-alkali and magnesium) and electroplating (e.g., coins)
  - equilibrium and Le Chatelier's Principle
- Hydrocarbons from fossil fuels are the raw materials for a wide range of synthetic chemicals.
  - hydrocarbon properties, nomenclature and reactions, petrochemical applications (e.g., fractional distillation, catalytic cracking and reforming, ethylene industry)
  - degradable plastics
- Chemistry is an essential component of environmental studies.
  - air quality (e.g. sulfur oxides, nitrogen oxides, photochemical smog)
  - water quality (e.g., BOD, heavy metals, organochlorines)
  - CFCs and depletion of ozone layer

Unit 4: Changes in Motion
(Key Science Concepts: Change, Energy)

- Motion is described in terms of displacement, time, velocity, and acceleration.
  - relative motion, speed, velocity, acceleration, free fall
  - vector addition, mathematical relationships, graphical treatment
- Newton's Laws of Motion describe the effects of forces on the motion of bodies.
  - First Law: inertia, mass, weight
  - Second Law: unbalanced forces, change in momentum, acceleration, mathematical relationships, impulse, friction
  - Third Law: action and reaction
- Uniform circular motion requires a constant unbalanced force.
  - rotational speed, centripetal acceleration, centripetal force
  - Newton's Law of Universal Gravitation, mathematical relationships
  - satellites, space exploration, simulated gravity
- The total momentum of any system of revolving or colliding bodies remains constant in the absence of outside forces.
  - Law of Conservation of Momentum, mathematical relationships
  - collisions, explosions

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Unit 1: The Human Body Responds to Its Environment
(Key Science Concepts: Equilibrium, Systems)

- The function of the nervous system is to provide immediate and specific response to external and internal environmental change to maintain homeostasis.
  - brain (brain stem, cerebellum, cerebrum), spinal cord, peripheral nervous system, transmission of nerve impulses
  - general sensory receptors (touch, heat, cold, pressure, pain)
  - special sensory receptors (taste, smell, sight, hearing)
- The cardiovascular system provides cells with raw materials, distributes useful products of cellular activities to all parts of the body, and transports the waste products of cellular activities to appropriate organs for elimination.
  - human blood (composition, blood types)
  - human heart (blood pressure, blood vessels)
  - nervous system control of cardiovascular system
- The human body is able to protect itself from disease by a complex set of defenses.
  - pathogens, disease transmission (e.g., air, water, human contact, arthropods)
  - nonspecific defense (skin, mucous membrane, phagocytes, fever)
  - specific defense (primary and secondary immune response)
  - immunity (natural immunity, vaccination, antibiotics)
  - immune disorders (allergies, rheumatoid arthritis, AIDS)
- Many human diseases and disorders have a genetic origin.
  - patterns of heredity, dominant and recessive traits
  - human genetics, single-gene inheritance, multiple-allele inheritance
  - sex-linked inheri ce (e.g., baldness, color-blindness)
  - chromosomal abnormalities (e.g., Downs syndrome)
  - disorders of genetic origin (e.g., cystic fibrosis, hemophilia, Huntington disease)
  - genetic counseling

Unit 2: Chemistry in the Body and the Environment
(Key Science Concepts: Matter, Change)

- Carbon compounds play a dominant role in the chemistry of living things.
  - organic functional groups: alcohols, aldehydes, ketones, acids, esters
  - food chemistry: carbohydrates, proteins, lipids, vitamins, minerals
  - pharmaceuticals, pesticides
- Acids and bases have a profound effect on the chemistry of aqueous systems.
  - acid/base theory, acid/base titrations, indicators
  - pH scale (pH calculations, titration curves)
  - buffers (maintaining blood pH)
- Acids and bases have many important environmental effects.
  - acid rain, accelerated corrosion, leaching of metals, effect on aquatic organisms
  - ombating acid rain (buffering capacity of soil, liming lakes)
  - transporting acidic and caustic chemicals
  - safe storage of acidic and caustic chemicals (WHMIS)

Unit 3: Telecommunications
(Key Science Concepts: Diversity, Energy)

- The technology of telecommunication is based on the principles of electricity and magnetism.
  - static electricity (Coulomb's Law)
  - current electricity (Ohm's Law)
  - electric & magnetic fields
  - telephone, tape recorder
- The technology of telecommunications uses the entire electromagnetic spectrum.
  - velocity of light = frequency X wavelength
  - radio waves (radio, radar, satellite communication, television)
  - microwaves (long range transmission of radio and TV)
  - infrared (remote sensing)
  - visible light (lasers, videodisk, fibre optics)
  - ultraviolet (detection by fluorescence)
  - X rays (internal body structure)
  - gamma rays (detecting flaws in steel beams and pipes)
- Modern astronomy is based on the electromagnetic energy emitted by celestial bodies.
  - spectra (emission, line, absorption), Doppler Effect
  - radio telescopes, space probes

Unit 4: Global Energy Sources
(Key science concepts: Energy, Diversity)

- The Sun is Earth's main source of energy.
  - radiant solar energy (passive solar heating, solar cells)
  - wind power, water power
  - energy stored by photosynthesis (food energy, biomass)
  - fossil fuels (coal, oil, natural gas)
- Nuclear changes involve much larger energy changes than chemical or phase changes.
  - nuclear fusion (in the sun, hydrogen bombs, fusion research)
  - nuclear fission (in the earth's core, fission reactors)
- The interaction of the gravitational fields of the Moon, Earth and Sun provides an additional source of energy.
  - tidal energy
- Current electricity provides a convenient means of transporting energy.
  - direct current
  - alternating current
  - transmission problems

DRAFT BIOLOGY 20-30 PROGRAM OUTLINE

The approach in the Junior High Science and Science 10 programs is experiential with the student being at the center of the learning. That approach is continued into the Biology Program where the learning is connected to the students own experiences and is facilitated by the reinforcement of topics in a spiral curriculum. The draft Biology Program builds on the students previous learning in Science and utilizes key science concepts through both years of the program.

BIOLOGY 20

Unit 1: Ecology: The Biosphere
(Key Science Concepts: Systems, Equilibrium)

- The biosphere is in a state of dynamic equilibrium.
  - the sun provides most of the biospheres energy
  - the biosphere influences the composition of the air
  - water cycles through the biosphere
  - nutrients cycle through the biosphere
- Human activity may disrupt the biosphere with short or long term consequences.

Unit 2: Organismal Chemical and Energy Cycles
(Key Science Concepts: Systems, Energy)

- Photosynthesis uses chlorophyll to trap light energy to reduce carbon dioxide to carbohydrates and oxygen.
- Respiration oxidizes carbohydrates in the presence or absence of oxygen to release energy and carbon dioxide.
- ATP from respiration and photosynthesis provides the energy for life processes.

Unit 3: Ecology: Ecosystems
(Key Science Concepts: Diversity, Energy)

- The biosphere is made up of a variety of different ecosystems.
  - analysis of local and other significant ecosystems
- Organisms are adapted to the physical and biological features of their environment.
  - climatic, edaphic, physiographic factors
  - plants, animals, decomposers
- Organisms interact with each other in an ecosystem by food webs and chains.
  - pyramids of numbers, biomass and energy
- The selection of favorable adaptations in populations of organisms over time drives evolution.
  - lines of evidence for evolution, natural selection

Unit 4: Maintenance Systems of Human Organisms
(Key Science Concepts: Equilibrium, Matter)

- Matter and energy is exchanged between humans and their environment to maintain their homeostasis.
  - the structure and function of digestive, excretory and respiratory systems
  - The distribution of matter within the organism is facilitated by a transport system.
  - the structure and function of the circulatory system
- Pathogens from the environment could disrupt homeostasis.
  - the immune system
- The human organism may malfunction due to biological or environmental causes.

Unit 1: Control Systems of Human Organisms
(Key Science Concepts: Equilibrium, Systems)

- Physiological control is maintained by electrical and chemically based systems.
  - structure and function of the nervous system
  - structure and function of the endocrine system

Unit 2: Reproduction and Development
(Key Science Concepts: Systems, Change)

- Humans have primary sexual characteristics.
  - structure and function of the reproductive organs
  - fertilization, development, parturition
- Humans have secondary sexual characteristics.
  - structure and function of mammary glands

Unit 3: Mitosis and Meiosis
(Key Science Concepts: Change, Diversity)

- Mitosis allows organisms to grow by increasing their cell numbers.
- Meiosis allows the reduction of chromosome numbers for sexual reproduction and provides some variability.

Unit 4: Mendelian Genetics
(Key Science Concepts: Diversity, Change)

- Inherited characters are passed down by simple rules.
- Mutation causes new characters to arise.

Unit 5: Molecular Genetics
(Key Science Concepts: Diversity, Change)

- Genetic information is contained in the structure of macromolecules.
- Biotechnology allows the precise manipulation of genetic material.

Unit 6: Ecology: Communities and Populations
(Key Science Concepts: Systems, Change)

- Natural communities may change over time.
  - succession, niches
- The genetic base of a population is at equilibrium under certain conditions.
- Populations grow until limited by the environment.
- Human population are not subject to normal biological constraints.

DRAFT CHEMISTRY 20-30 PROGRAM OUTLINE

The intent of the Chemistry 20-30 program will be to build upon students' previous learnings in science. The approach is intended to be experiential and student centered. Wherever possible, learning will be connected to the students' own experiences and facilitated by the reinforcement of topics in a spiral curriculum. The focus will be on learning the key interconnecting ideas and principles of science, fostering positive attitudes, developing skills and increasing students' understanding of chemistry, science process, and the connections among science, technology and society. This outline briefly delineates the units proposed for the Chemistry 20-30 program of studies.

CHEMISTRY 20

Unit 1: Solutions and Gases
(Key Science Concept: Matter)

- The majority of chemical processes take place in solution.
  - water as a solvent, solubility, concentration
  - equilibrium in solute-solvent systems
  - electrolytes, non-electrolytes
  - acids, bases, dissociation, pH, neutralization
  - common everyday solutions, industrial solutions, body fluids, environmental waters
- A model of the gaseous state provides insight into molecular behaviour.
  - KMT theory, ideal and real gases
  - Avogadro's hypothesis, molar volume
  - role of gases in daily life
  - air quality, greenhouse gases, ozone

Unit 2: Quantitative Relationships in Chemical Reactions
(Key Science Concept: Change)

- Balanced chemical equations indicate quantitative relationships among the reactants and products involved in chemical reactions.
  - gravimetric, solution and gas stoichiometry
  - volumetric and gravimetric analysis
  - careers in chemistry related to quantitative analysis
  - monitoring the environment depends on analytical chemistry

Unit 3: Chemical Bonding
(Key Science Concepts: Matter, Energy)

- Bonding between atoms results from the transfer or sharing of electrons.
  - ionic and covalent bonds
  - electronegativity, valence, stable octets
  - periodicity and the periodic table
  - Lewis structures
  - properties of substances relate to bonding
  - reactions between metals and nonmetals are examples of simple oxidation-reduction
  - synthesis of new substances depends on an understanding of bonding

Unit 4: An Introduction to Organic Compounds
(Key Science Concepts: Matter, Diversity)

- Organic compounds comprise most of the known chemicals.
  - characteristics, major classifications
  - hydrocarbons: sources, characteristics, uses, categories, nomenclature
  - significant hydrocarbon derivatives
  - biochemicals: carbohydrates, proteins, lipids, etc.
  - impact on our lives and the environment

CHEMISTRY 30

Unit 1: Thermochemistry
(Key Science Concepts: Energy, Change)

- There are energy changes associated with changes to matter.
  - comparison of phase, chemical and nuclear changes
  - kinetic and potential energy, energy diagrams
  - heat of reaction, heat of formation, Law of Hess
  - energy from fossil fuels, greenhouse effect
  - alternative energy sources

Unit 2: Equilibrium, Acid and Base Chemistry
(Key science concepts: Systems, Equilibrium, Change)

- Chemical systems involving gases and solutions can be viewed as a dynamic equilibrium.
  - equilibrium in chemical reactions
  - applications of Le Chatelier's Principle
  - Bronsted-Lowry Theory, conjugate pairs, buffers
  - indicators, pH, pOH, titration, stoichiometry
  - acid rain, metal leaching

Unit 3: Electrochemistry
(Key Science Concepts: Matter, Change)

- Electrons are exchanged in oxidation-reduction reactions.
  - oxidizing and reducing agents, oxidation, reduction
  - electrochemical and electrolytic cells
  - quantitative relationships
  - applications of oxidation-reduction reactions

Unit 4: Organic Chemistry
(Key Science Concepts: Matter, Diversity, Change)

- Organic chemistry principles are illustrated by some key reactions of organic compounds.
  - combustion, substitution, addition in hydrocarbons
  - condensation and addition polymerization in the production of plastics
  - important biochemical reactions
  - safety considerations, health hazards, disposal questions

DRAFT PHYSICS 20-30 PROGRAM OUTLINE

The emphasis on the student as an active learner in the junior high school and grade ten science programs will be continued in the Physics 20-30 program. Wherever appropriate, a spiral approach to concept development will be followed and learnings will be connected to the students' own experiences through practical applications. Suitable reference to the connections to the other sciences and between classical and contemporary physics will be made whenever possible.

PHYSICS 20

Unit 1: Kinematics and Dynamics
(Key Science Concepts: Energy, Matter, Change)

The kinematic and dynamic concepts, introduced in Science 10, are extended into a formal graphical and algebraic treatment.

- The motion of objects and systems can be described in terms of position, time, velocity and acceleration.
  - scalars and vectors
  - uniform linear motion
  - uniform accelerated motion
  - two-dimensional motion
  - relative motion
- Forces are the cause of motion.
  - forces (vector addition)
  - weight (acceleration due to gravity, motion near the surface of the earth)
  - Newton's laws of motion explain and describe the motion of objects and systems
  - mechanical energy, work and power

Unit 2: Gravitation
(Key Science Concepts: Systems)

This unit serves as an extension of the kinematics and dynamics of the previous unit, and an introduction to periodic motion.

- Gravitational forces influence motion throughout the universe.
  - gravitational field (field concept introduced descriptively)
  - circular motion (a special case of two dimensional motion)
  - Newton's universal law
  - Kepler's laws

Unit 3: Mechanical Waves
(Key Science Concepts: Energy, Matter)

This unit serves to link mechanics to the light unit.

- Vibrations cause disturbances called waves, a means to transfer energy.
  - SHM as an introduction to waves
  - wave characteristics and behavior
  - water and sound waves as examples of mechanical waves
  - vibrations in strings and tubes to demonstrate wave behaviour and characteristics
  - Doppler effect

Unit 4: Light
(Key Science Concepts: Energy, Diversity]

•Light, a visible form of energy.
- properties and propagation of light
- ray optics
- mirrors and lenses
- color
- wave and particle model (introduction)

Unit 5: Nuclear Physics and Radioactivity
(Key Science Concepts: Energy, Matter, Change, Diversity)

- Energy and matter interact. A descriptive treatment serving as an introduction to the topic.
  - nuclear structure
  - nuclear forces
  - radioactivity
  - radioactive decay (alpha, beta, gamma)
  - biological effects of radiation
  - fusion and fission
  - reactors

PHYSICS 30

Unit 1: Conservation Laws
(Key Science Concepts: Energy, Equilibrium)

•Conservation laws are fundamental to the functioning of the universe.
- conservation of energy
- conservation of momentum (vector analysis)
- impulse
- scalar/vector laws

Unit 2: Electric Forces and Fields
(Key Science Concepts: Diversity)

- The electric nature of matter plays a major role in scientific and technological development.
  - electrostatics
  - Coulomb's Law
  - electric fields
  - electric charges in electric fields
  - electric energy
  - simple electric circuits

Unit 3: Magnetic Forces and Fields
(Key Science Concept: Diversity)

- The interaction between electricity and magnetism is fundamental to physical principles.
  - magnetic fields
  - magnetic fields and electric current
  - charges in magnetic fields
  - motors, generators, meters, transformers
  - introduction to A.C. concepts
  - electromagnetic radiation

Unit 4: Nature of the Atom
(Key Science Concept: Matter, Diversity)

- The study of the nature of the atom lead to a new view of our universe.
  - electric nature of the atom
  - emission and absorption spectra
  - Rutherford - Bohr
  - inadequacies of the Bohr model

Unit 5: Waves and Particles
(Key Science Concept: Energy, Matter)

- The particle-like behavior of light suggests that an ordinary particle has a wave-like nature.
  - Planck - blackbody radiation
  - photoelectric effect
  - Compton effect, deBroglie
  - wave - particle duality
  - quantum mechanical model of the atom

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